

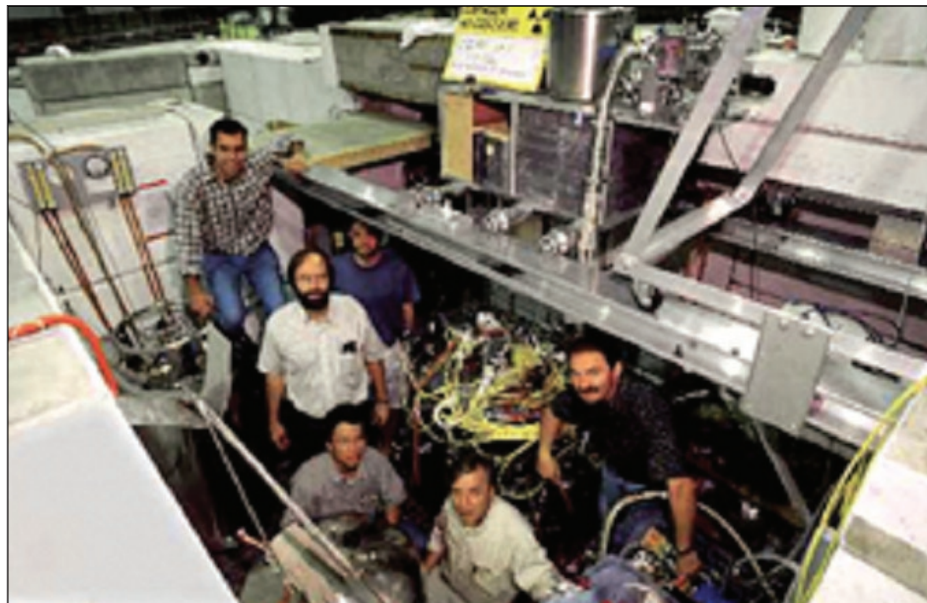


# Air Force Research Laboratory|AFRL

*Science and Technology for Tomorrow's Air and Space Force*

## **Success Story**

### **LOOKING IN FROM THE OUTSIDE: ANTIMATTER ATOMS**



The antimatter atoms collaboration, known as the ATRAP Collaboration, developed a novel field-ionization technique that permits direct observation of antihydrogen atoms that eliminate residual background signals. ATRAP can detect more antihydrogen atoms in an hour than the sum of all antimatter atoms ever reported.



Air Force Research Laboratory  
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## Accomplishment

Dr. Gerald Gabrielse, a Harvard University professor of physics, worked with scientists from Germany, England, and the United States to observe the internal structure of antimatter atoms. Since 1988, the Air Force Office of Scientific Research's (AFOSR) Physics and Electronics Directorate helped sponsor Dr. Gabrielse's efforts at the European Laboratory for Particle Physics, also known as CERN, in Geneva, Switzerland.

## Background

AFOSR's support permitted CERN to build the antiproton decelerator (AD) storage ring in order to observe cold antihydrogen. Antihydrogen is an atom composed of two antimatter particles, an antiproton and a positron; a normal hydrogen atom is composed of a proton and an electron.

The antiparticles have the same mass as their normal counterparts, but they carry the opposite charge. Current theories predict that antihydrogen and hydrogen should have the same properties including their internal structure.

The ATRAP team creates antihydrogen atoms by colliding antiprotons with cold positrons. The ATRAP team creates antiprotons from CERN's AD and positrons from a radioactive source. They cool them both and gently collide them to form antiatoms, namely antihydrogen. The antihydrogen forms in a nested Penning trap, a device developed by ATRAP scientists. Then they study them spectroscopically.

The ultimate goal of ATRAP is to trap neutral cold antihydrogen atoms and study their spectra with the same precision as plain hydrogen atoms. Researchers hope that the antihydrogen atoms will create enough atoms to allow lasers to probe for any tiny differences between antihydrogen and hydrogen atoms. Such measurements would test fundamental theories of physics and might even provide some information about the mystery of why our universe is composed of matter rather than antimatter.

Antihydrogen -- and antimatter in general -- has many potential benefits to the military and defense of our nation. It is a potential candidate for extremely high-energy density applications. These include ultralightweight satellite and unmanned air vehicle power supplies, high specific impulse engines, and missile defense interceptors.

## Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (03-OSR-09)